Southern Illinois University Carbondale
OpenSIUC

Research Papers Graduate School

2014

Cochlear Implants: Factors Influencing Speech and Language Development in Children

Haley Rinella
hayhud@live.com

COCHLEAR IMPLANTS: FACTORS INFLUENCING SPEECH AND LANGUAGE DEVELOPMENT IN CHILDREN

by

Haley Rinella

B.S., Southern Illinois University, 2011

Research Paper
Submitted in Partial Fulfillment of the Requirements for the
Masters of Science

Department of Rehabilitation Institute
in the Graduate School
Southern Illinois University Carbondale
May 2014

RESEARCH PAPER APPROVAL

COCHLEAR IMPLANTS: FACTORS INFLUENCING SPEECH AND LANGUAGE DEVELOPMENT IN CHILDREN

By

HALEY RINELLA

A Research Paper Submitted in Partial

Fulfillment of the Requirements

for the Degree of

Masters of Science

in the field of Communication Disorders and Sciences

Approved by:

Sandie Bass-Ringdahl, Ph.D., CCC-A, Chair

Graduate School
Southern Illinois University Carbondale
April 3, 2014

TABLE OF CONTENTS

Introduction

Research has shown that speech and language development occur in predictive stages. Stark (1980) categorized speech development into the following stages: reflexive sounds, cooing, vocal play, reduplicated babbling, single words and non-reduplicated babbling. A typically developing child with normal hearing will start with the reflexive stage and progress to the single words/reduplicated babble stage. However, a child with a severe to profound hearing loss will not. Children with bilateral, profound hearing losses show substantial delays and deficits in vocal development (Stark, 1980). Children with hearing loss show a different vocal development pattern. Their development is characterized by late onset of canonical babble, restricted formant frequency ranges in vowel-like vocalizations, longer durations of final syllables, comparatively small consonant, vowel, and syllable shape, and a lack of jargon and protowords (Ertmer et al., 2007).

Onset of canonical babble has been found to distinguish infants with normal hearing from infants with hearing impairment (Ertmer et al., 2007). A canonical babble is a vocalization with an adult like consonant and vowel sound. The vocalization has a rapid transition from consonant sound to vowel sound. Typically developing infants begin canonical babble between six to eight months of age (Ertmer et al., 2007). At this chronological age, an infant's anatomy has developed enough to produce these sounds. Research has shown that profound hearing loss results in delays of five to 19 months in the onset of canonical babble in infants with hearing impairment. When canonical babble does develop in infants with hearing impairment it is typically limited and restricted to sounds that are visible (e.g., bilabials), acoustically salient (e.g., vowels), and/or provide tactile feedback (e.g., laryngeal). Additionally, reduplicated babble (e.g., /baba/ or /didi/) is often absent in infants with hearing impairment (Ertmer et al., 2007). Therefore, late onset, or lack of canonical babble, is a red flag for hearing loss.

Children with profound hearing losses who do not benefit from hearing aids may benefit from the cochlear implant. A cochlear implant (CI) is a prosthetic device that electrically stimulates the auditory nerve. It has both internal and external parts. A surgeon must place the internal receiver and electrodes. The receiver is placed just under the skin behind the ear and the electrodes are inserted into the cochlea. The electrodes stimulate the auditory nerve, and sound sensations are perceived. The external parts include a microphone, speech processor, and transmitter. Currently, to receive a CI, a child must have bilateral, profound sensorineural hearing loss, be at least twelve months of age, have worn a hearing aid for three months, and be approved by a CI team (Muse et al., 2013).

Research supports that, in general, children with CIs learn spoken language better than children with severe-profound hearing impairment without a CI or with hearing aids alone (Geers et al., 2003; Tomblin et al., 1999). Therefore, CIs offer an opportunity for better speech and language outcomes for children with profound sensorineural hearing loss. However, speech and language development in children with CIs is variable. Svirsky et al. (2000) found that the language of children with CIs fell between 1 and 2 standard deviations below their peers with normal hearing. A second study of language development by Schorr, Roth, and Fox (2008) found that children with CIs fell within 1 standard deviation below their peers with normal hearing when scores were adjusted for nonverbal intelligence and socioeconomic status (SES). A great deal of research has been conducted to determine the factors that are responsible for this variability among children with CIs. Factors investigated include: age of identification, age of implantation, amount of audibility prior to implantation, educational/intervention factors, device factors, and home environment factors.

Cochlear implantation has become the gold standard of care for the development of spoken language in children with severe to profound bilateral hearing loss who do not benefit from hearing aids. However, the medical setting's standard of care is ahead of the research in many ways. Research supports that early implantation and early identification are key variables for better speech and language outcomes in children with cochlear implants (Muse et al., 2013). Yet, there is still a large amount of variability in the speech and language outcomes of children with cochlear implants (Pisoni et al., 1999). This research paper will investigate factors which influence speech and language development in children, birth to fifth grade, with cochlear implants. While many variables will be discussed, the main focus will be on environmental or factors in the home.

Age of Identification

A main factor that influences speech and language development in children with CIs is age of identification of hearing loss. Research surrounding speech and language development in children with cochlear implants has changed due to newborn hearing screening. In the past, researchers examined speech and language development in children who were implanted during the preschool years or later. However, with a mandate for newborn hearing screening in all but two states, children are being identified earlier than ever before. Earlier identification leads to earlier implantation. Early implantation leads to improved speech and language outcomes. The American Academy of Pediatrics (AAP, 2010), and the Joint

Committee on Infant Hearing (JCIH, 2007) recommended "1-3-6" benchmarks for the newborn hearing screening process: complete newborn hearing screening by one month of age, diagnose hearing loss by three months of age, and enroll those identified with hearing loss into early intervention by six months of age (Muse et. al., 2013).

Age at Implantation

Age at implantation is another factor that influences speech and language development in children with CIs. Multiple studies support that earlier implantation leads to better speech and language outcomes. One such study by Nicholas & Geers (2007) found that children who received a cochlear implant before a substantial delay in spoken language developed (between 12 and 16 months) were more likely to achieve age-appropriate spoken language. The age of the child at the time of CI surgery was shown to have a significant effect on overall language level. The authors found that the effect of age at implant on language level was more significant than the effect of duration of implant use (Nicholas & Geers, 2007). A final study by James et. al, (2008) found that early-implanted children performed better on language measures than late-implanted children; however, there was enough variation in each group to conclude that age of implantation does not solely explain outcome variations.

Pre-Implant Auditory Experience

Another factor that contributes to speech and language development in children with cochlear implants is the amount of auditory experience prior to implantation. Auditory experience is determined by how much of the speech signal a child is able to hear and understand prior to implantation. Some children hear sound pre-implant with their residual hearing through the use of hearing aids. The amount of the speech signal a child can hear is based on his/her degree of hearing impairment. Auditory experience builds speech perception. When a child cannot detect or perceive the speech signal, auditory deprivation can occur. For these children, early implantation is important to capitalize on the plasticity of the auditory system available at younger ages (Nicholas & Geers, 2007).

Auditory experience is important for typical speech development. In typical development, infants begin to develop speech perception abilities well before they begin to produce words. In contrast, children with CIs begin to develop an awareness of the acoustic features of consonants, vowels, and words at roughly the same time as they begin to produce words. Rather than having extensive exposure to acoustic phonetic percepts prior to attempting words, young CI recipients acquire words as their auditory systems are acquiring new stimulation (Ertmer et al., 2007). It is important to consider that some children have no auditory experience pre-implantation, therefore they have not been able to perceive speech.

Education and Intervention

Education and intervention are the next factors that influence speech and language development in children with CIs. Children who receive a CI and oral education before age 24 months of age are generally capable of exhibiting levels of spoken language that are comparable with hearing age-mates before they enter kindergarten (Ertmer et al., 2007). The likelihood of achieving normal language levels in preschool decreases as age of implantation increases. Children with CIs have the best speech and spoken language outcomes when an oral-only or total communication modality is implemented. The spoken language outcomes of oral-only and total communication programs have not proven to be significantly different. Education and intervention should begin as soon as a child is identified with a hearing impairment and therefore, before the child is implanted with a CI. As mentioned before, the "1-3-6" benchmarks: screening by one month, diagnosis by three months, and intervention by six months are important for optimal speech and language outcomes (Muse et al., 2013).

Device Factors

The device is another important factor to consider. Each cochlear implant is mapped individually for the receiving child.

It is important to remember that a CI does not restore normal hearing (Geers et al., 2003). A CI gives an electrical representation of sound instead of an acoustic representation as the cochlea does. The time it takes for a child's CI to be mapped for the best listening experience may vary. The goal is to obtain an optimal MAP, or settings, as soon as possible so as not to cause further delay in speech and spoken language development. Finally, the integrity of the auditory nerve and the etiology of the hearing loss (e.g., congenital or trauma) impact how sound is interpreted by the brain following implantation.

Home Environment Factors: Parent Talk

The remaining discussion will focus on the influence a child's home environment has on speech and language outcomes. Children with CIs who have home environments with more parent talk tend to display better speech and language development than home environments that have less parent talk.

According to Hart & Risley (1995), parental input contributes to language development in hearing children. Children whose parents talk more to them generally have better language skills and perform better later in school than those who are exposed to less language at home. Findings from Hart & Risley (1995) are important to consider with the cochlear implant population. Additionally, studies report that children of higher SES families receive more and better quality language input than those in lower SES households. Moeller (2000) and Yoshinaga-Itano (1998), found that high levels of family involvement correlated with positive language outcomes. Limited family involvement was associated with significant child language delays at five years of age, especially when enrollment was late (i.e., after six months). Results suggested that language success is achieved when early identification (i.e., before two years) is paired with early intervention (i.e., by six months) that actively involves families (Yoshinaga-Itano, 1998).

Gilkerson and Richards (2008) investigated the natural home language environment using the LENA device. The LENA device is an automatic system for measuring key elements of the child's language learning environment. It is a small recording device that is worn on the body. Gilkerson and Richards (2008) consisted of two phases. Phase I involved 329 participants aged two to 48 months. These participants were recorded with the LENA device for at least 12 consecutive hours once a month for six months. Phase II involved 80 participants selected from Phase I to provide a representative sample with respect to the children's overall language ability and mothers' attained education. Standard language assessments were administered. The results indicated that scores on language and cognitive assessments were related to the amount of adult talk in the environment. Children who scored higher on language and cognitive assessments (90-99th percentiles) had parents who talked more. Children who scored lower on the language assessments were exposed to less adult talk, engaged in fewer conversational turns, vocalized less frequently, and had lower expressive language skills. The difference in the mean number of adult words spoken to advanced children (scoring 90-99th percentiles) compared to all other children was 2,295 words or 191 words per hour (Gilkerson & Richards, 2008).

To investigate the impact of parent talk on predicting later language ability, Gilkerson and Richards (2008) further analyzed data on 27 children from the Phase II longitudinal sample of the LENA study. The average adult word counts from these recordings were compared to average *PLS-4* Total Language standard scores given every 24 months. The authors found that the more adult talk children were exposed to in the first six months, the higher their language ability scores were a year or more later.

The importance of the home environment and parent talk on speech and spoken language development in children with CIs was also supported by Szagun et al., (2012). Their study investigated the influence of social environmental variables and age at implantation on language development in children with cochlear implants. Twenty five children with cochlear implants ranging from six months to 42 months were assessed for linguistic progress at 12, 18, 24, and 30 months after implantation. Language measures were obtained from parental questionnaires and spontaneous speech samples at each interval. Higher levels of maternal education were associated with faster linguistic progress. Additionally, maternal language input, mean length of utterance, and expansions were associated with a child's linguistic progress independently of age at implantation. The authors concluded that, in children implanted within the sensitive period for language learning, children's home language environment contributes more crucially to linguistic progress than does age at implantation (Szagun et al., 2012)..

VanDam, Ambrose, and Moeller (2012) investigated whether quantity of linguistic input is altered in the home environment of children with mild to severe hearing loss who utilize hearing aids compared to those with normal hearing. They obtained 30 full day recordings of families with a child ranging from 24 to 36 months of age. Twenty-two of the families had a child who was hard of hearing, the remaining children had normal hearing. The authors found comparable performance between children with normal hearing and children who are hard of hearing for adult word count (i.e., 15,000-17,000 words a day) and conversational turns (VanDam et al., 2012). Their findings suggest that a child's hearing status has limited influence on the average quantity of parent talk that occurs in the child's environment. VanDam, Ambrose, and Moeller (2012) claimed that children's language skills do not appear to contribute to the quantity of adult words to which they are exposed, but child language abilities are positively related to the number of conversations engaged in by parents and children.

The adult word count that was calculated for the VanDam, Ambrose, and Moeller (2012) investigation was not exclusively measuring child-directed speech (i.e., speech that is intended for the child to hear and respond). Thus, child-directed speech may be particularly important in promoting the language skills of children who are hard of hearing. The microphone on the LENA recording device records all talk within a defined radius. Therefore, it picks up both adult-to-adult talk and talk directed to the child. The results from the VanDam, Ambrose, and Moeller (2012) study revealed that quantity of adult words may not be as important as quality—such as conversations and conversational turns. The VanDam, Ambrose, and Moeller (2012) study included children with hearing aids and not cochlear implants; however, it is reasonable to conclude that the findings are important to consider with the CI population as they are also hearing impaired. Future studies should be conducted to validate these results for the CI population (VanDam et al., 2012).

Both Gilkerson and Richards (2008) and VanDam, Ambrose, and Moeller (2012) used the LENA recording device to obtain data. This device is worn on the targeted child throughout the day. One concern for the use of this device is that the family is aware that they are being recorded. This awareness might influence the amount of talk they engage in. Although the LENA provides the opportunity to research the home language environment, its presence may alter the home language environment. It should also be noted that many participants who agree to CI research are more educated and of higher SES. Research does support that children from more educated, higher SES homes are more likely to have higher speech and language development outcomes (Geers, Nicholas, & Sedey, 2003).

Holt et al. (2012) evaluated the family environments of children with CIs and the relationships between post implant language development and executive function. Forty-five families of children with CIs completed a self-report family environment questionnaire and an inventory of executive function. The children in the study completed a receptive vocabulary test and global language skills evaluation. The authors analyzed the results and found that families with higher levels of self-reported control (i.e., used many set rules and procedures for running the family unit) had children with smaller vocabularies. They also found that families reporting a higher emphasis on achievement had children with fewer executive function and working memory problems. Families reporting higher emphasis on organization had children with fewer problems related to inhibition. This study stated that parenting style accounted for more variability in speech and language outcomes than the amount of parent talk (Holt et al., 2012).

In summary, amount of parent talk has been shown to be related to higher speech and language development outcomes. However, quality may be more important than quantity. Parenting style including where emphases are placed (i.e., control, achievement, organization) and amount of conversations and conversational turns may be more important to speech and language development than the number of adult words spoken to a child. Importantly, the home language environment can be modified and enhanced through therapy and education (Holt et al., 2012). Future research should focus on quality of the home language environment.

Home Environment Factors: Conversational Turns

Research supports that children with CIs who experience more conversational turns with their parents will have better speech and language outcomes than children who experience less conversational turns. Conversational turns are adult-child speech alternations. The study by Gilkerson and Richards (2008), mentioned earlier, also investigated the quantity of conversational turns in the home environment. Not only did children who scored higher on language assessments (90-99th percentiles) have parents who talked more, they also took more conversational turns. The mean difference in conversational turns between advanced children and their parents compared to all other children was 214 turns—almost 18 more conversational turns than all other children (Gilkerson & Richards, 2008).

The previous study by VanDam, Ambrose, and Moeller (2012) also investigated conversational turns. They found that parents of hard of hearing children engaged their children in conversational turns at comparable levels to the parents of children with normal hearing (VanDam et al., 2012). This lack of difference between parents suggests that child hearing status does not influence the frequency of conversational turns. Future research should examine the complexity of conversational talk as these measures were not included in the study's measure of conversational turns.

Home Environment Factors: Family Involvement

Research supports that children with CIs who experience more family involvement will have better speech and language outcomes than children who experience less family involvement. Higher levels of family involvement correlate with positive speech and language outcomes for children with cochlear implants. Moeller (2000) investigated the relationship between age of enrollment in intervention and language outcomes at five years of age in a group of children who were deaf or hard of hearing. A rating scale was developed to characterize the level of family involvement in the intervention program for the children of the study. Moeller (2000) found that family involvement and age of enrollment were significant factors in explaining the variance in language scores of the children in the study. High levels of family involvement correlated with positive language outcomes, and limited family involvement correlated with significant child language delays at five years of age. These results suggested that higher levels of family involvement can overcome the effects of late enrollment. Therefore, family involvement may be one of the more important factors contributing to speech and language outcome variance among children with CIs.

Spencer (2004) investigated parent involvement in a study that looked at language skills of a multicultural sample of thirteen children with prelingual deafness who received CIs between fourteen and 38 months of age. During this study, parents completed a qualitative interview regarding their experiences with the identification of their child's hearing loss, their resources and process in making the decision to obtain a CI, and their evaluation of their child's progress since implantation. Spencer (2004) found that parent involvement was positively associated with children's language skills. Parents who reported extended and intense involvement in the decision making process had children who had better language outcomes. Additionally, these same parents reported being highly involved in learning and advocacy at home and in educational programs (Spencer, 2004).

Quittner et al. (2013) examined the effects of parental behaviors on language outcomes. This study observed the effects of maternal sensitivity (MS), cognitive stimulation, and linguistic stimulation (LS) on the oral language development of 188 CI recipients and 97 children with normal hearing. Maternal sensitivity, cognitive stimulation, and linguistic stimulation were determined after hearing loss, age at implantation, and demographic variables were controlled. The study found that maternal sensitivity and cognitive stimulation predicted increases in language growth. Linguistic stimulation was related to language growth only in the context of high maternal sensitivity. At 48 months post-implantation, children of parents with higher maternal sensitivity and linguistic stimulation exhibited 1.52-year less delay compared to those with either lower maternal sensitivity or lower linguistic stimulation. However, all children were found to have a language delay when compared to the children with normal hearing in the study. A more in depth analysis of the study revealed that at 48 months post-implantation, children of parents with higher maternal sensitivity exhibited a 1.3-year language delay, compared with the 2.7-year delay in children of parents with low maternal sensitivity. Cognitive stimulation was also a significant and unique predictor of oral language growth over the 4-year period. Children of parents who engaged in more cognitive stimulation had a 1.4-year language delay, compared with a 2.6-year delay in children of parents who used less cognitive stimulation. Linguistic stimulation was also related to improved language development, but only in the context of high maternal sensitivity. Children of parents with both high maternal sensitivity and high linguistic stimulation had only a 1.0-year delay in language, compared with 2.5-years in the other groups (i.e., low MS, high LS; high MS, low LS; and low MS, low LS) (Quittner et al., 2013).

Geers et al. (2003) investigated factors contributing to the comprehension and production of English language by children with pre-lingual deafness after four to seven years of multichannel CI use. The authors found that parent participation was not significant factor in language development for their study participants. Language tests were given to 181 eight and nine year olds with CIs. Spoken language measures, child and family characteristics, and type of educational intervention were considered. They found that higher nonverbal intelligence, smaller family size, higher family socio-economic status, and female gender predispose children to higher levels of language development (Geers et al., 2003). Additionally, children with CIs whose educational focus was on oral communication and who were in mainstream classrooms had better language development. Other educational factors including hours of therapy, therapist experience, parent participation, and public/private school were not significant in speech and language developmental outcomes for the children in this study with CIs (Geers et al., 2003).

Pisoni et al. (1999) investigated the "stars" of cochlear implantation. These were the children who were exceptionally good users of cochlear implants. The authors found that there were no pre-implant predictors of outcome performance in young children. This contradicts the research by Geers et al. (2003) discussed earlier. Instead Pisoni et al. (1999) claimed that the underlying perceptual, cognitive, and linguistic abilities and skills emerge after implantation and improve over time. This study suggested that higher-level central processes such as perception, attention, learning, and memory play important roles in the variability of speech and language outcomes in children with cochlear implants (Pisoni et al., 1999). The findings from Pisoni et al. (1999) conflict with the factors previously discussed as accounting for the variability seen in the speech and language outcomes of children with CIs. It should be noted that Pisoni et al. (1999) was conducted on children who were implanted at much older ages than is now recommended and that this difference in age at implantation may account for the lack of congruence with more recent studies. Nonetheless, Pisoni et al. (1999) reminds researchers of the importance of the brain and the child's native, cognitive ability in determining outcome.

Discussion

Research supports that home environment factors (e.g., family involvement) account for much of the variation in speech and language development outcomes seen in children with cochlear implants. However, multiple variables work together to determine an individual child's speech and language outcomes. These variable include: age of identification, age of implantation, predisposing factors, educational factors, and home environment factors. None of these factors explains variability alone, rather, speech and language development occurs due to a combination of all factors working together within a particular child. These factors are important for professionals to consider clinically. Professionals who work with children need to be educated about hearing loss. It is important to consider the signs of hearing loss, such as late onset of canonical babble. Professionals should be aware of the milestones and typical stages of development of normal speech and language. Early identification of hearing loss is important for all children—regardless of whether they have CIs or hearing aids. Professionals must be ready to identify these children, refer them for appropriate testing, and counsel and educate families on how to help their children achieve the best speech and language outcomes.

Additional research is needed regarding the speech and language development in children with CIs. Now that earlier identification, implantation, and enrollment in intervention are the gold standard, studies are needed to determine which factors contribute most to the successful speech and language outcomes in this new cohort of children. In addition, research is needed to better inform the medical community regarding the implantation of children with two cochlear implants versus one cochlear implant. Research must keep pace with technological advances in order to provide parents with informed decision making. In this way, parents are in the best position to optimize their child’s speech and language development.

REFERENCES

American Academy of Pediatrics, Task Force on Newborn and Infant Hearing (1999). Newborn and infant hearing loss: detection and intervention. *Pediatrics*, 103, 527-530.

American Speech-Language-Hearing Association (1994). Joint Committee on Infant Hearing Position Statement. *American Speech-Language-Hearing Association,* 38-41.

Ertmer, D., Young, N., & Nathani, S. (2007). Profiles of vocal development in young cochlear implant recipients. *Journal Of Speech, Language & Hearing Research*, *50*(2), 393-407.

Geers, A.E., & Brenner, C. (2003). Background and educational characteristics of prelingually deaf children implanted by five years of age. *Ear & Hearing,* 24, 2S-14S.

Geers, A. E., Nicholas, J. G., & Sedey, A. L. (2003). Language skills of children with early cochlear implantation. *Ear & Hearing*, *24*(1S), 46-49. Retrieved July 5, 2013.

Gilkerson, J., & Richards, J. A. (2009). Impact of adult talk, conversational turns, and tv during the critical 0-4 years of child development. *The Power of Talk*, 1-30. Retrieved July 13, 2013.

Hart, B. & Risley, T. R. (1995). Meaningful differences in the everyday experience of young American children. Baltimore, MD: Brookes Publishing Company, Inc.

Holt, R., Beer, J., Kronenberger, W. G., Pisoni, D. B., & Lalonde, K. (2012). Contribution of family environment to pediatric cochlear implant users' speech and language outcomes: Some preliminary findings. *Journal Of Speech, Language & Hearing Research*, *55*(3), 848-864. doi:10.1044/1092-4388(2011/11-0143).

James, D., Rajput, K., Brinton, J., & Goswami, U. (2008). Phonological awareness, vocabulary, and word reading in children who use cochlear implants: does age of implantation explain individual variability in performance outcomes and growth?. *Journal Of Deaf Studies & Deaf Education*, *13*(1), 117-137.

Moeller, M. (2000). Early intervention and language development in children who are deaf and hard of hearing. *Pediatrics*, *106*(3), E43.

Muse, C., Harrison, J., Yoshinaga-Itano, C., Grimes, A., Brookhouser, P., Epstein, S. (2013). Supplement to the JCIH 2007 position statement: Principles and guidelines for early intervention after confirmation that a child is deaf or hard of hearing. *Pediatrics*, *131*(4), e1324-e1349. doi:10.1542/peds.2013-0008.

Nicholas, J., & Geers, A. (2007). Will they catch up? The role of age at cochlear implantation in the spoken language development of children with severe to profound hearing loss. *Journal Of Speech, Language & Hearing Research*, *50*(4), 1048-1062.

Pisoni, D., Cleary, M., Geers, A., & Tobey, E. (1999). Individual differences in effectiveness of cochlear implants in children who are prelingually deaf: new process measures of performance. *Volta Review*, *101*(3), 111-164.

Quittner, A. L., Cruz, I., Barker, D. H., Tobey, E., Eisenberg, L. S., & Niparko, J. K. (2013). Effects of maternal sensitivity and cognitive and linguistic stimulation on cochlear implant users' language and development over four years. *The Journal of Pediatrics*, *162*, 343- 348. Retrieved February 3, 2014.

Schorr, E. A., Roth, F. P., & Fox, N. A. (2009). Quality of Life for Children With Cochlear Implants: Perceived Benefits and Problems and the Perception of Single Words and Emotional Sounds. *Journal Of Speech, Language & Hearing Research*, *52*(1), 141-152.

Spencer, P. E. (2004). Individual differences in language performance after cochlear implantation at one to three years of age: Child, family, and linguistic factors. *Journal of Deaf Studies and Deaf Education*, *9*(4), 395-412. doi:10.1093/deafedenh033.

Stark, R. E. (1980). Stages of speech development in the first year of life. In G. Yeni-Komshian, J. Kavanaugh, & C. Ferguson (Eds.), *Child phonology,* (1), 73-90.New York: Academic Press.

Szagun, G., Stumper, B., Oetting, J., & Tobey, E. (2012). Age or experience? The influence of age at implantation and social and linguistic environment on language development in children with cochlear implants. *Journal Of Speech, Language & Hearing Research*, *55*(6), 1640-1654. doi:10.1044/1092-4388(2012/11-0119).

Svirsky, M. A., Robbins, A. M., Kirk, K., Pisoni, D. B., & Miyamoto, R. T. (2000). Language Development in Profoundly Deaf Children with Cochlear Implants. *Psychological Science*, (2), 153. doi:10.2307/40063514.

Tomblin, J., Spencer, L., Flock, S., Tyler, R., & Gantz, B. (1999). A comparison of language achievement in children with cochlear implants and children using hearing aids.

Journal Of Speech, Language & Hearing Research, *42*(2), 497-511.

VanDam, M., Ambrose, S. E., & Moeller, M. P. (2012). Quantity of parental language in the home environments of hard-of-hearing 2-year-olds. *Journal of Deaf Studies and Deaf Education*, *17*(4), 402-420. Retrieved July 10, 2013.

Yoshinaga-Itano, C. L. (1998). Language of Early- and Later-identified Children With Hearing Loss. *Pediatrics*, *102*(5), 1161.

VITA

Graduate School
Southern Illinois University

Haley Rinella

hayhud@live.com

Southern Illinois University Carbondale

Bachelor of Science, Biological Sciences, May 2011

Research Paper Title:

COCHLEAR IMPLANTS: FACTORS INFLUENCING SPEECH AND LANGUAGE DEVELOPMENT IN CHILDREN

Major Professor: Sandie Bass-Ringdahl, Ph.D., CCC-A